Consumer and Corporate Affairs Canada
Consommation et Corporations Canada

(11) (A) No. 1 181 700

(45) ISSUED 850129

(52) CLASS 183-116

(51) INT. CL.[3] B01D 45/12

(19) (CA) CANADIAN PATENT (12)

(54) Two-Stage Liquid Separator

(72) Doyle, Glen H.,
Canada

(21) APPLICATION No. 418,265

(22) FILED 821221

No. OF CLAIMS 14

Canada

DISTRIBUTED BY THE PATENT OFFICE, OTTAWA.
CCA-274 (11-82)

TWO-STAGE LIQUID SEPARATOR

ABSTRACT OF THE DISCLOSURE

A two-stage separator for liquid/gas separation includes a cylindrical outer casing with an internal cyclone assembly concentrically mounted therein, in the upper portion of said outer casing. The annulus between the internal cyclone and the outer casing form a first or outer cyclone separator for the moisture laden gas which spirals upwardly depositing any droplets or liquid slugs onto the inner surface of the outer casing. The gas then passes through slots in the outer casing of the internal cyclone assembly and spirals downwardly at an increased velocity thereby depositing any remaining liquid from the gas stream which then exits upwardly through a central outlet of the inner cyclone assembly. The liquid from both separating stages flows down the casing to the base thereof and an automatic level control, controls a vessel drain valve.

TWO-STAGE LIQUID SEPARATOR

BACKGROUND OF THE INVENTION

This invention relates to new and useful improvements in cyclone type separators designed to separate liquid from gas, particularly wet gas streams from gas wells and the like.

Conventionally, such separators utilize a standard cyclone separator but it has been found that this is insufficient to remove the relatively high concentration of moisture often found in the gas flowing from gas wells.

SUMMARY OF THE INVENTION

The present invention overcomes these disadvantages by providing for two stages of separation in order to ensure complete removal of liquids from the gas.

The wet gas stream enters the main body of the separator through a tangential inlet nozzle and this sets up a spiral flow pattern in the separator. Liquid slugs and droplets are removed by gravity and centrifugal force generated by the spiral flow and this initial separation removes the major portion of the liquids from the gas stream.

The gas stream then continues to spiral up the body of the separator and enters the top end of an inner cyclone section of the separator. This section of the separator ac-

complishes the final liquid removal from the gas stream. Due to the smaller diameter, this section of the separator causes a greater velocity of the gas and hence a greater centrifugal force acting on the liquid droplets which is much higher than in the initial section of the separator.

This section is a true cyclone separator and removes any remaining liquids with the flow pattern being in a spiral flow downwardly from the upper end towards the lower end at which point the flow reverses and spirals upwardly to the gas outlet pipe. The liquid removed from the gas stream collects on the walls of the cyclone and flows downwardly to the bottom of the cyclone separator and hence through a downcomer pipe to the liquid section of the separator.

In accordance with the invention there is provided a two-stage separator for the removal of liquids from a gas comprising in combination a vertically situated, cylindrical outer casing, an internal cyclone assembly mounted concentrically within said outer casing and in the upper portion thereof, said internal cyclone assembly including a substantially cylindrical inner cyclone casing defining an annular space between said inner cyclone casing and said outer casing and constituting a first stage liquid separator, said internal cyclone assembly constituting a second stage liquid

separator, gas inlet means communicating through said inner cyclone casing from said annular space to the interior of said inner cyclone assembly, an inner cyclone assembly downcomer extending from said inner cyclone casing to adjacent the base of said outer casing, a gas outlet pipe concentrically mounted within said inner cyclone casing and extending through the upper end of said outer casing and a wet gas inlet through said outer casing adjacent the lower end of said inner cyclone casing, said wet gas inlet directing gas into said annular space tangentially.

The two-stage separation of the device provides high performance for a wide variety of applications. Slugs of liquid are easily handled because the liquids enter the large area of the main body or first stage liquid separation. The mist and fine droplets are then efficiently removed in the smaller inner cyclone assembly of the separator which constitutes the second stage separation.

It has been found that this separator provides almost complete removal of liquids over the complete range of pressures and flow rates normally encountered in producing gas wells. Liquid removal rates of up to 150 BBl. per day were handled readily and easily. Gas flow rates through the unit of course vary with the gas pressure and it has been found that extremely high volumes of gas can be handled

at high pressure.

Another advantage of the invention is to provide a device of the character herewithin described which is simple in construction, economical in manufacture and otherwise well suited to the purpose for which it is designed.

With the foregoing in view, and other advantages as will become apparent to those skilled in the art to which this invention relates as this specification proceeds, the invention is herein described by reference to the accompanying drawings forming a part hereof, which includes a description of the best mode known to the applicant and of the preferred typical embodiment of the principles of the present invention in which:

DESCRIPTION OF THE DRAWINGS

Figure 1 is a partially schematic, partially sectioned isometric view of the two-stage separator.

Figure 2 is a substantially vertical cross section of the separator.

Figure 3 is a schematic view showing the liquid control assembly.

Figure 4 is a top plan view of Figure 2.

In the drawings like characters of reference indicate corresponding parts in the different figures.

DETAILED DESCRIPTION

Proceeding therefore to describe the invention in de-

tail, a circular base 10 supports a vertically situated cylindrical outer casing 11 which is closed at the upper end 12 thereof.

Situated within the upper end of this casing is an internal cyclone assembly collectively designated 13 and this is mounted concentrically within the upper end by conventional means (not illustrated) such as welding or other support means.

The internal cyclone assembly 13 includes a substantially cylindrical inner cyclone casing 14 extending from and sealed to the upper end 12 of the outer casing and defining an annular space 15 between the internal cyclone casing and the outer casing 11 which constitutes the first separating stage as will hereinafter be described. It will therefore be appreciated that the internal cyclone assembly 13 constitutes the second stage separator of the device.

The internal cyclone casing 14 constitutes an upper major portion 16 and a lower inverted cone-shaped portion 17 with the diameter of the upper portion 16 being constant throughout its length down to the junction thereof to the lower inverted cone-shaped portion 17, said junction being indicated by reference character 18.

A downcomer pipe or conduit 19 extends downwardly from the lower or narrow end 20 of the cone-shaped portion

and is angulated as at 21 so that the lower portion 22 thereof is adjacent the wall of the outer casing. The lower discharge end 23 terminates spaced above the base 24 of the outer casing, said base including an outlet or discharge conduit 25 incorporated with a valve 26, which will hereinafter be described.

The internal cyclone assembly 13 also includes a gas outlet pipe or conduit 27 situated concentrically within the upper portion 16 of the casing 14 and extending upwardly through the upper end 12 of the outer casing 11 to be connected by means of flange 28, to a further conduit (not illustrated). The lower end 28A of this gas outlet pipe terminates approximately half way down the length of the upper portion 16 of the casing 14 and spaced above the junction 18 as clearly shown in Figure 2.

Means are provided connecting the annular space 15 with the interior of the internal cyclone assembly 13, said means taking the form of a plurality of vertically situated equidistantly spaced slots 29 formed through the wall of the internal cyclone casing 14 adjacent the upper end 30 thereof.

A wet gas inlet 31 extends through the wall of the outer casing 11 and is connectable to a source of gas via flange 32 and it should be noted that this wet gas intake 31 extends through the casing adjacent the lower end 20 of

the inverted cone-shaped portion 17. Furthermore, this wet gas inlet directs the gas into the outer casing in a tangential fashion and this together with the inverted cone-shaped portion 17, facilitates the spiralling of the gas upwardly around the annular space 15 as indicated by the track 33 in Figure 1.

As it spirals upwardly within this outer space, droplets and slugs of liquid are deposited by centrifugal force, upon the inner surface of the outer casing 11 and they flow downwardly by gravity, to the lower end of the outer casing.

As this partially dried gas reaches the upper end of the annular space, it enters the internal cyclone assembly through slots 29 and because it cannot escape upwardly, it is forced to spiral downwardly around the annular space defined between the gas discharge pipe or conduit 27 and the inner wall of the internal cyclone casing 14. This part is indicated by the track 34 in Figure 1.

Due to the smaller diameter of the inner cyclone casing 14, the velocity is greater so that the centrifugal force is also greater thus causing the remaining liquid to be deposited outwardly onto the inner surface of the internal cyclone casing 14 whereupon it flows downwardly of the inner casing 14, downwardly through the inverted cone portion 17 and into the downcomer tube 19 to be discharged from

the lower end 23 thereof into the outer casing 11.

As the gas spirals downwardly, the inverted cone portion 17 causes a restriction which forces the gas upwardly through the gas discharge conduit 27 as indicated by the dotted line 35 in Figure 1, with the liquid from both separators being collected in the lower end portion of the outer casing.

A ring or other protruberance 28B is formed around the outer surface of the conduit 27 adjacent the lower end 28A thereof and catches or intercepts any liquid moving downwardly on the outer surface of the conduit 27 and deflects it back into the gas stream.

An automatic level control assembly may be provided and is shown schematically in Figure 3 by reference character 36. It consists of a float assembly 37 which may be moved upwardly by the level of the liquid, said float operating a valve assembly 38 externally of the casing which in turn connects an air supply via conduits 39 and 40 to a control 41 which operates a drain valve 41A in a liquid outlet tube 41B through the wall of the outer casing 11 just above the lower end 24 thereof.

The float control assembly is engaged through the outer casing via screw threaded nipple 42 shown in Figures 1 and 2 and a box-like shield assembly 43 is situa-

ted within the lower portion of the casing and is open at the lower end 44 thereof so that liquid can flow upwardly to operate the float assembly 37. This shielding casing is to prevent any turbulence which may be present in the liquid, particularly during draining, from affecting the float assembly.

It will be observed that the lower end 24 of

the casing terminates spaced above the base 10 with a surrounding shield portion 11A of the casing extending between the lower end 24 and the base 10. The aforementioned drain tube or conduit 25 extends through this portion and into the centre of the base 24 of the casing and is used to clean out the assembly if and when required, it being understood that the automatic draining of the liquid occurs through the valve assembly in the outlet conduit 41B.

Finally, note should be taken of nipple 45 which supports a conventional temperature and pressure gauge (not illustrated) and nipples 46,a conventional liquid level gauge (also not illustrated).

It will therefore be seen that a simple and efficient two-stage gas separator is provided particularly adapted for use with high pressure, high volume wet gas treatment.

Since various modifications can be made in my invention as hereinabove described, and many apparently widely different embodiments of same made within the spirit and scope of the claims without departing from such spirit and scope, it is intended that all matter contained in the accompanying specification shall be interpreted as illustrative only and not in a limiting sense.

CLAIMS:

(1) A two-stage separator for the removal of liquids from a gas comprising in combination a vertically situated, cylindrical outer casing, an internal cyclone assembly mounted concentrically within said outer casing and in the upper portion thereof, said internal cyclone assembly including a substantially cylindrical inner cyclone casing defining an annular space between said inner cyclone casing and said outer casing and constituting a first stage liquid separator, said internal cyclone assembly constituting a second stage liquid separator, gas inlet means communicating through said inner cyclone casing from said annular space to the interior of said inner cyclone assembly, an inner cyclone assembly downcomer extending from said inner cyclone casing to adjacent the base of said outer casing, a gas outlet pipe concentrically mounted within said inner cyclone casing and extending through the upper end of said outer casing and a wet gas inlet through said outer casing adjacent the lower end of said inner cyclone casing, said wet gas inlet directing gas into said annular space tangentially.

(2) The separator according to Claim 1 in which said gas inlet means through said inner cyclone casing comprises a plurality of vertically situated, equidistantly spaced slots formed through said inner cyclone casing adjacent the

upper end thereof.

(3) The separator according to Claim 1 in which said internal cyclone assembly includes an inverted cone-shaped lower end portion, said downcomer extending from the lower narrow end of said cone-shaped lower end portion.

(4) The separator according to Claim 2 in which said internal cyclone assembly includes an inverted cone-shaped lower end portion, said downcomer extending from the lower narrow end of said cone-shaped lower end portion.

(5) The separator according to Claim 3 in which said wet gas inlet is situated adjacent but above said lower narrow end of said cone-shaped portion.

(6) The separator according to Claim 4 in which said wet gas inlet is situated adjacent but above said lower narrow end of said cone-shaped portion.

(7) The separator according to Claim 3 in which the lower intake end of said gas outlet pipe is situated spaced above the upper end of said inverted cone-shaped lower portion.

(8) The separator according to Claim 4 in which the lower intake end of said gas outlet pipe is situated spaced above the upper end of said inverted cone-shaped lower portion.

(9) The separator according to Claim 5 in which

the lower intake end of said gas outlet pipe is situated spaced above the upper end of said inverted cone-shaped lower portion.

(10) The separator according to Claim 6 in which the lower intake end of said gas outlet pipe is situated spaced above the upper end of said inverted cone-shaped lower portion.

(11) The separator according to Claims 1, 2 or 3 which includes a fluid level control assembly operatively connected within said lower portion of said outer casing, a drain valve within said outer casing adjacent the lower end thereof and means operatively connected between said fluid level control assembly and said drain valve for operating said drain valve responsive to the fluid level within said lower portion of said outer casing, and shield means around said fluid level control assembly to shield same from turbulence of the liquid within said outer casing.

(12) The separator according to Claims 4, 5 or 6 which includes a fluid level control assembly operatively connected within said lower portion of said outer casing, a drain valve within said outer casing adjacent the lower end thereof and means operatively connected between said fluid level control assembly and said drain valve for operating said drain valve responsive to the fluid level with-

in said lower portion of said outer casing, and shield means around said fluid level control assembly to shield same from turbulence of the liquid within said outer casing.

(13) The separator according to Claims 7, 8 or 9 which includes a fluid level control assembly operatively connected within said lower portion of said outer casing, a drain valve within said outer casing adjacent the lower end thereof and means operatively connected between said fluid level control assembly and said drain valve for operating said drain valve responsive to the fluid level within said lower portion of said outer casing, and shield means around said fluid level control assembly to shield same from turbulence of the liquid within said outer casing.

(14) The separator according to Claim 10 which includes a fluid level control assembly operatively connected within said lower portion of said outer casing, a drain valve within said outer casing adjacent the lower end thereof and means operatively connected between said fluid level control assembly and said drain valve for operating said drain valve responsive to the fluid level within said lower portion of said outer casing, and shield means around said fluid level control assembly to shield same from turbulence of the liquid within said outer casing.

ADE & COMPANY
1710 - 360 Main Street
Winnipeg, Manitoba
R3C 3Z3

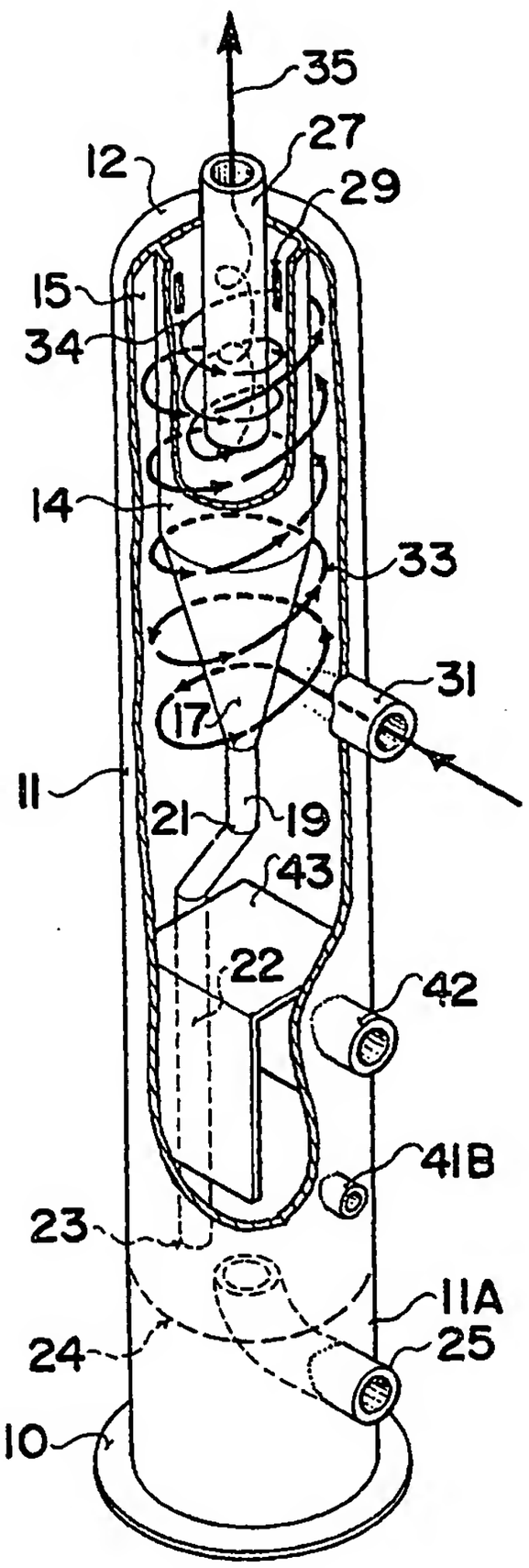

FIG. 1

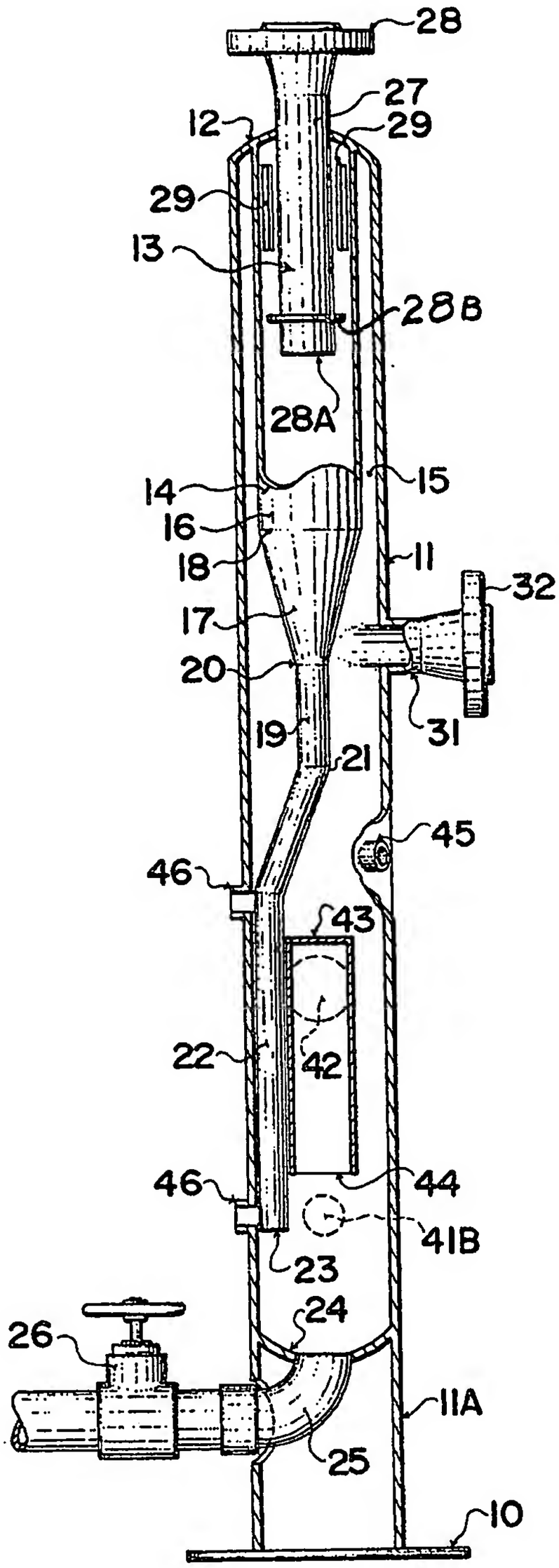

FIG. 2

Inventor: GLEN H. DOYLE

By: Able & Company

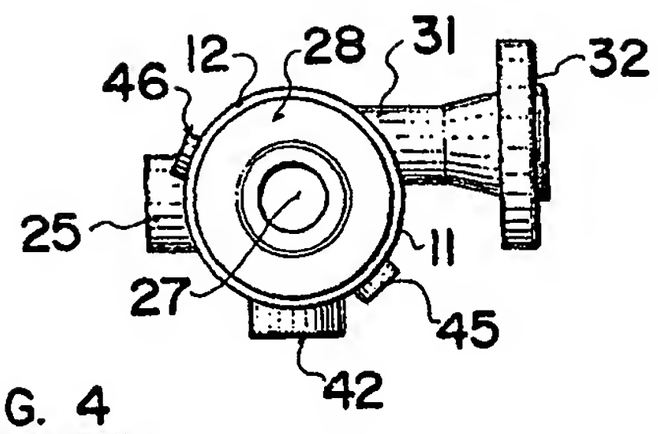

FIG. 4

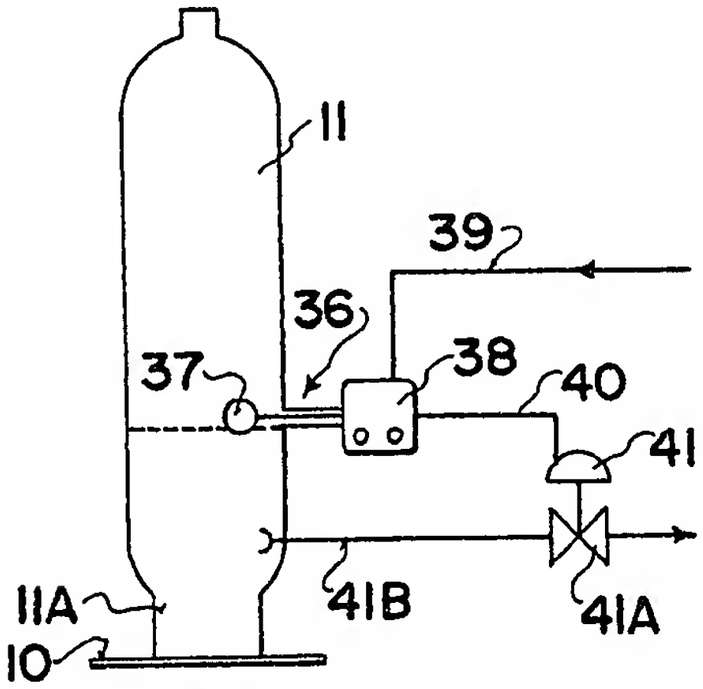

FIG. 3

Inventor: GLEN H. DOYLE

By: Ade & Company